Sector Installation Tool

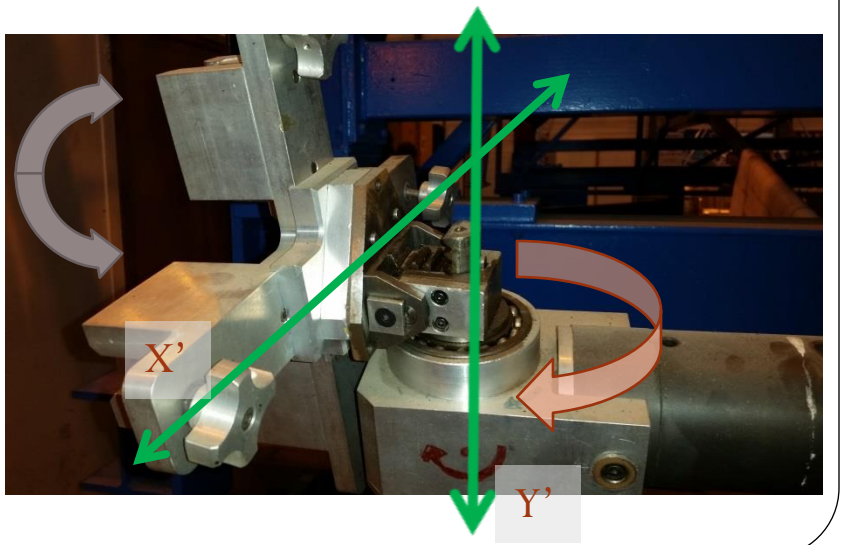
- Rahul Sharma

Sector Installation

Why Old setup can't be used?

- No crane access to the TPC face.
- Modifying existing tooling by adding counterweights increase the tooling weight to more than a 2.5times the existing weight of tooling and TPC (made of aluminum) has not enough safety factor to handle that load.

Cartesian Concept



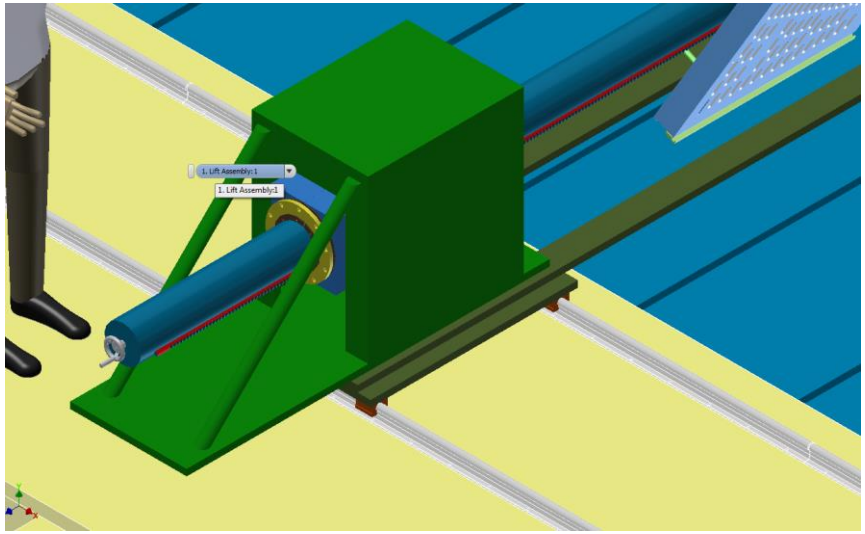
Tool and Hydraulic Platform Features

Platform Features:

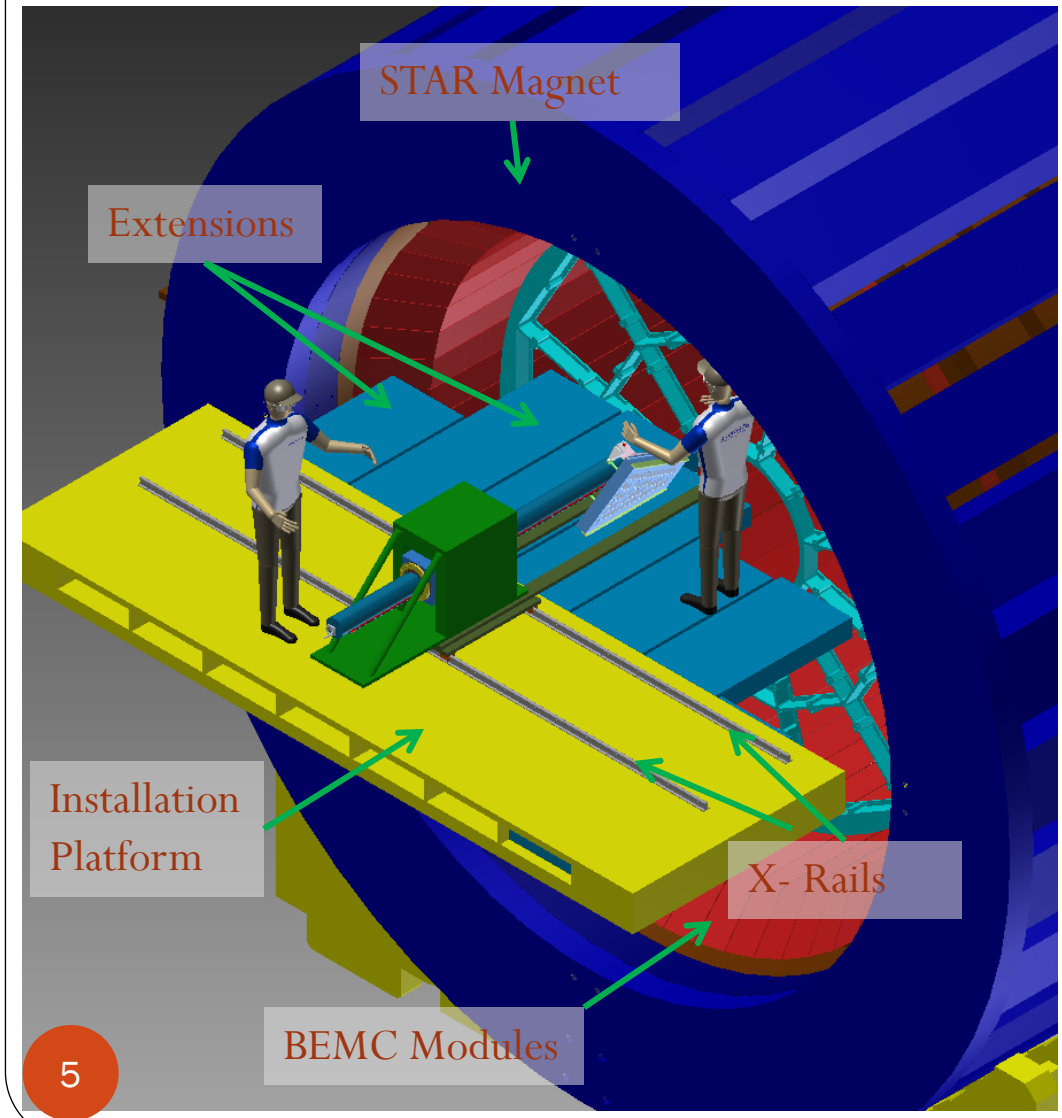
- Range of motion inY to work between the heights 6feet to 19 feet.
- Rough adjustment in X for tool positioning.
- 5 to 6 foot long extension that allows us to be close to the TPC face.

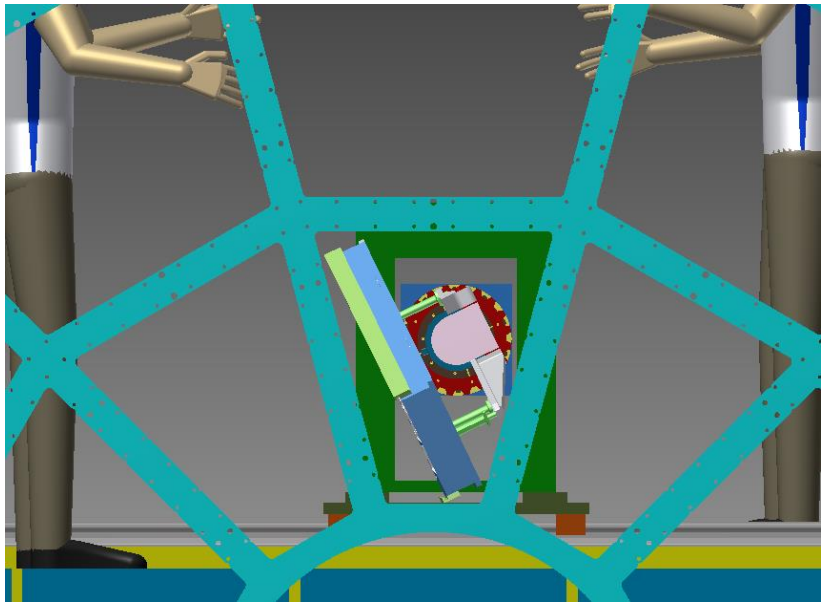
Tool Features

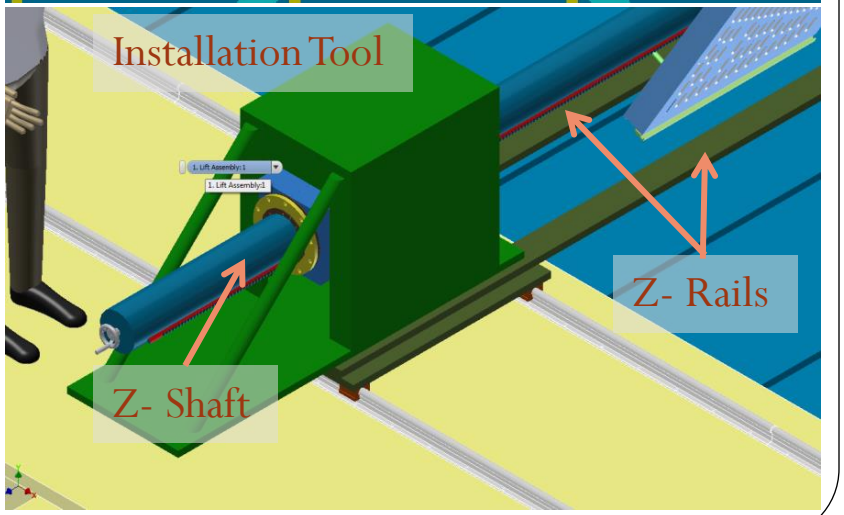
- Contain stages for fine x, y and z motions.
- Tool head will provide rotational adjustment around x' and y' axes (similar to alice tool
- Lightweight (<700 pounds)
- A set of rails for rough positioning in Z



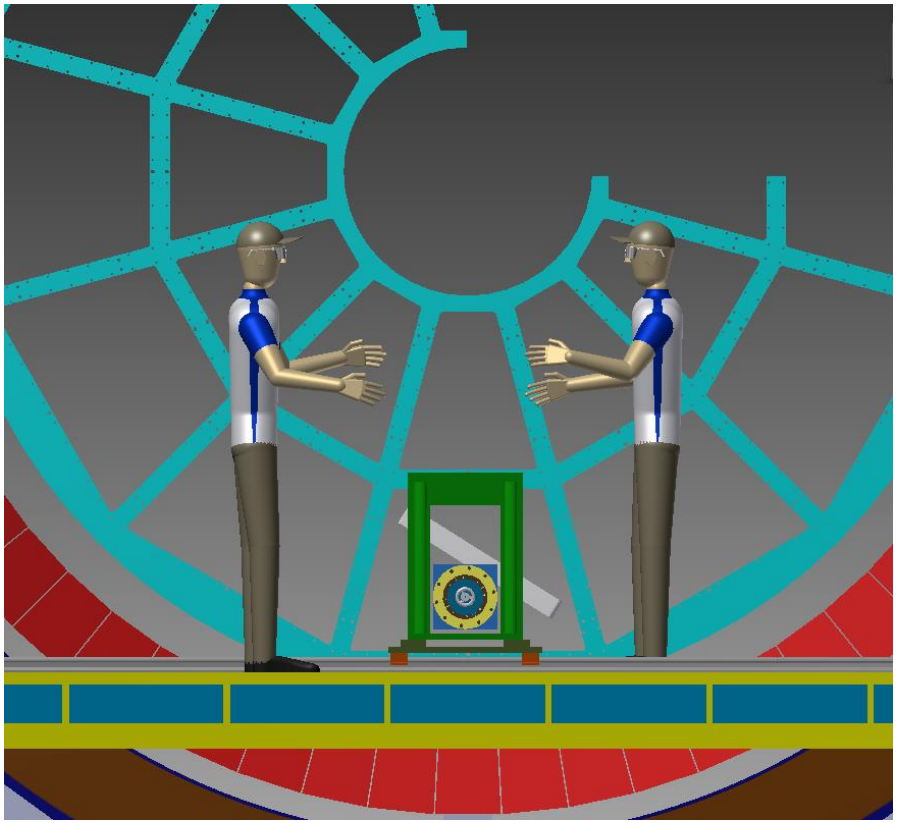
Cartesian Installation Tool Design

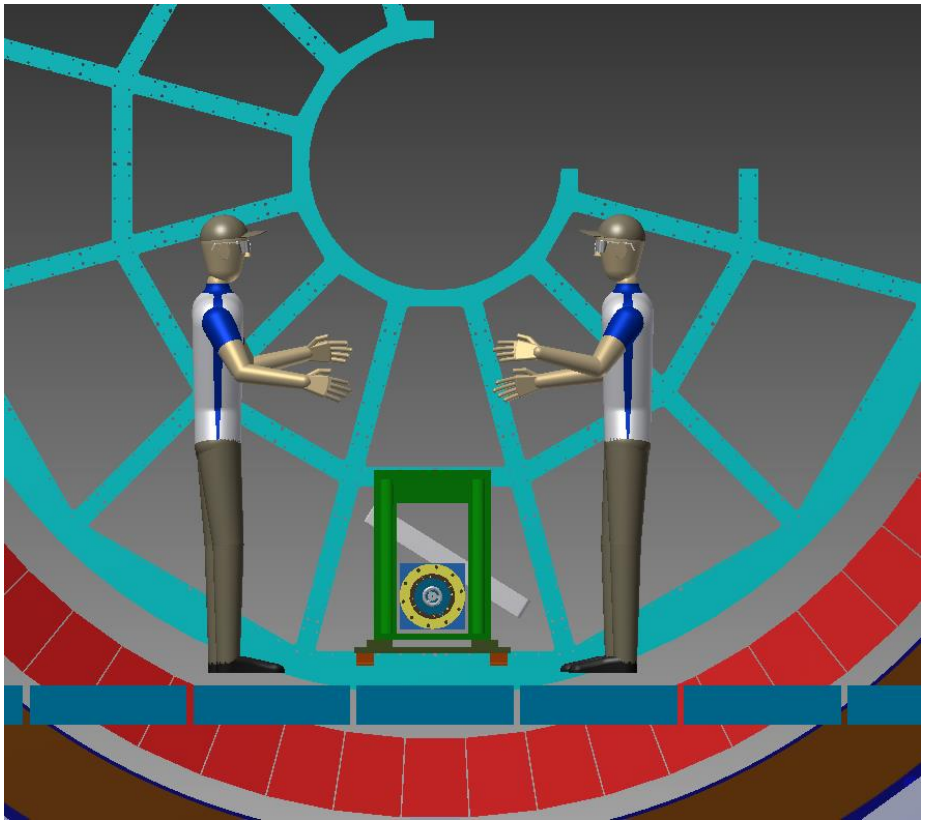






Installing 6 o'clock outer sector





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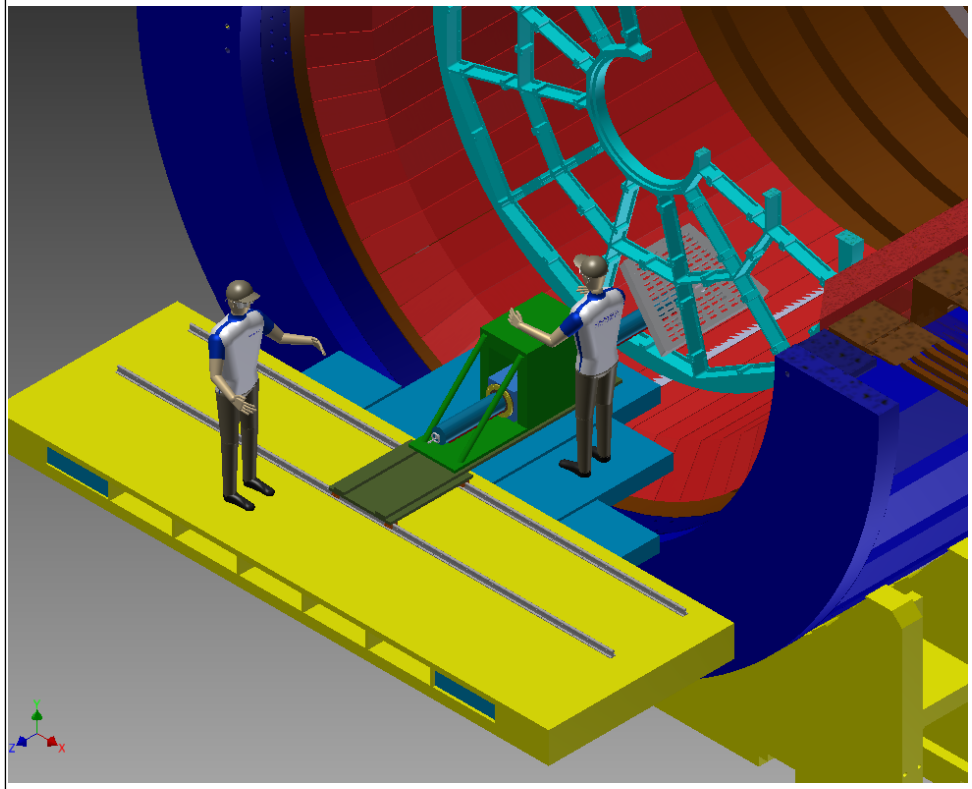
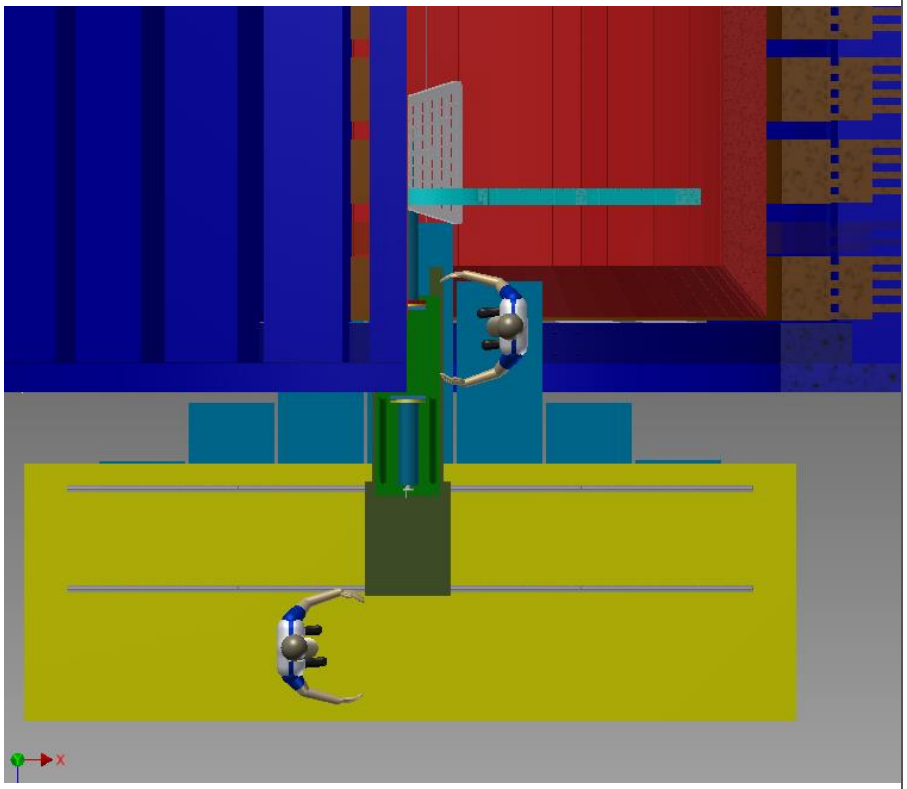
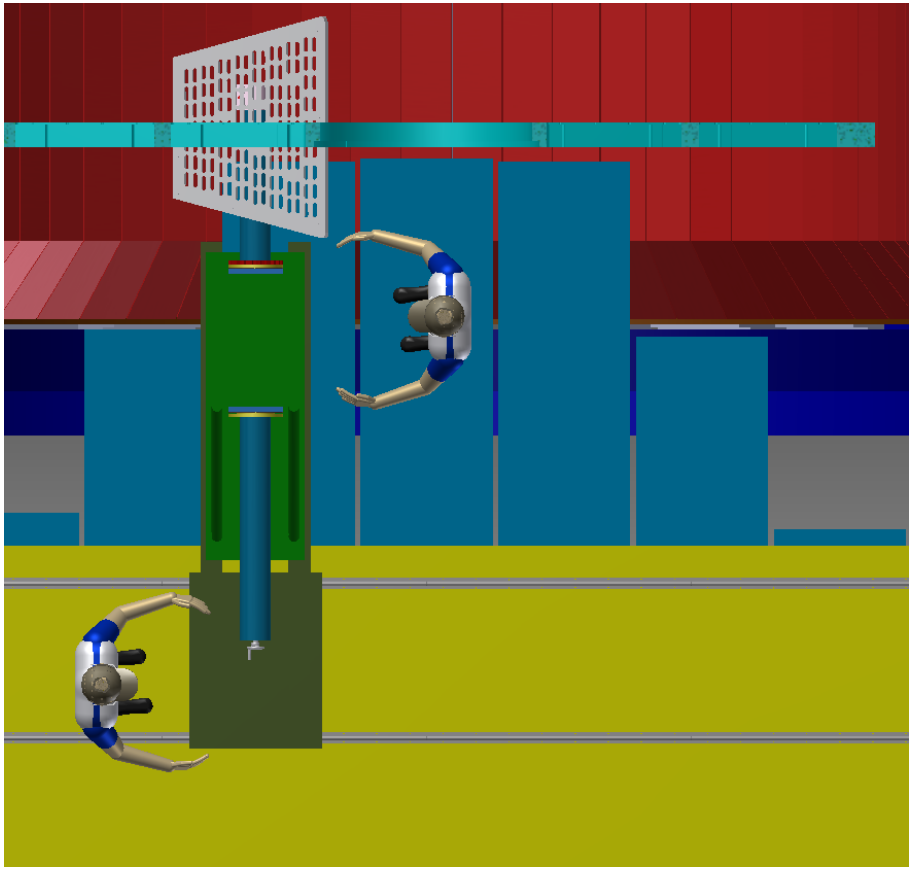
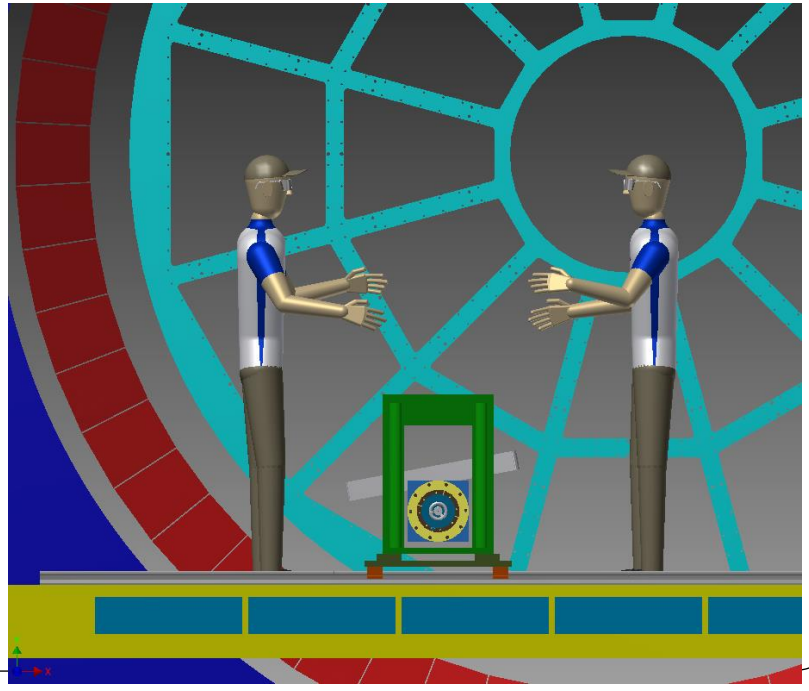


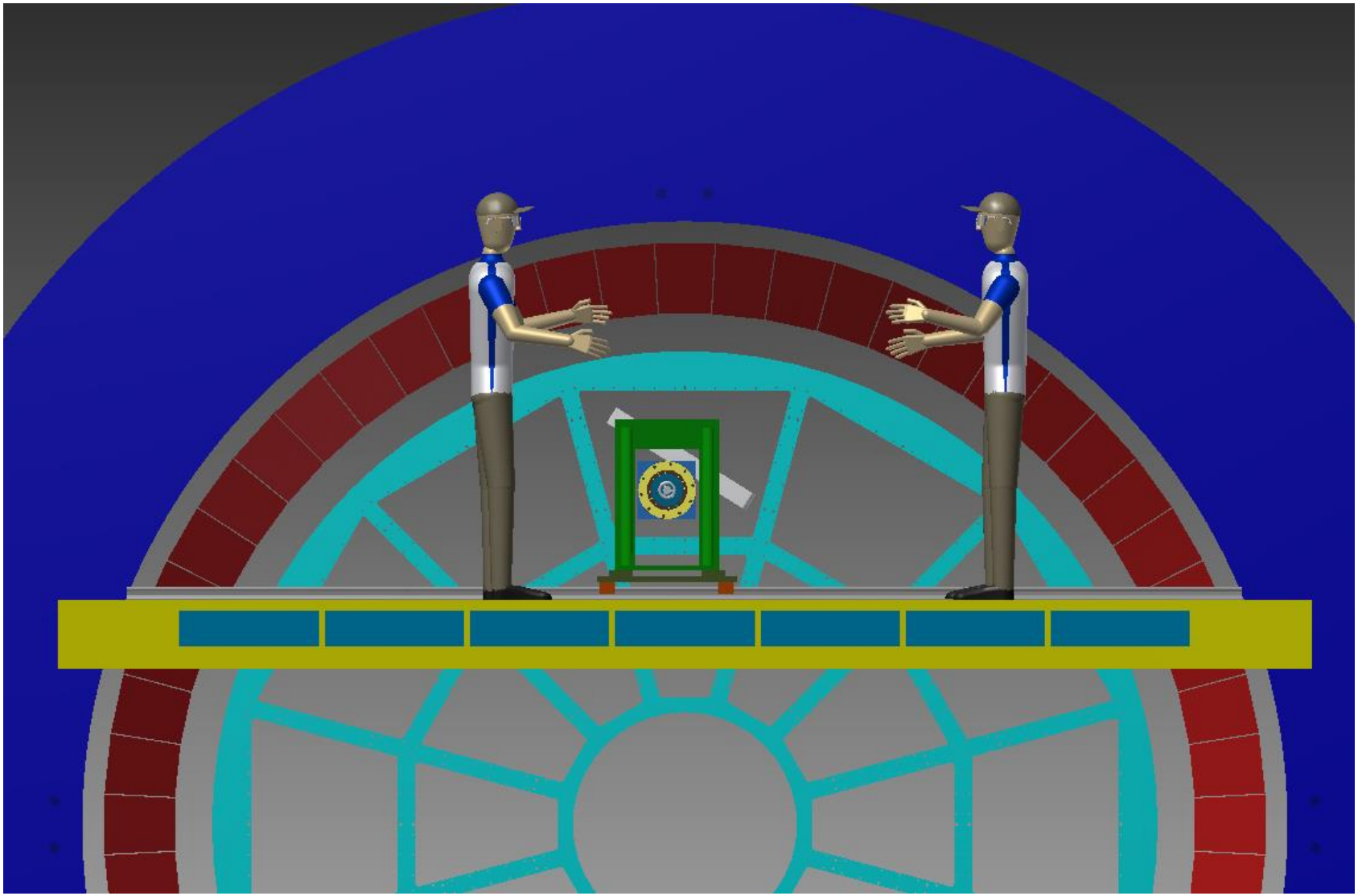


Installing 7 o'clock outer sector

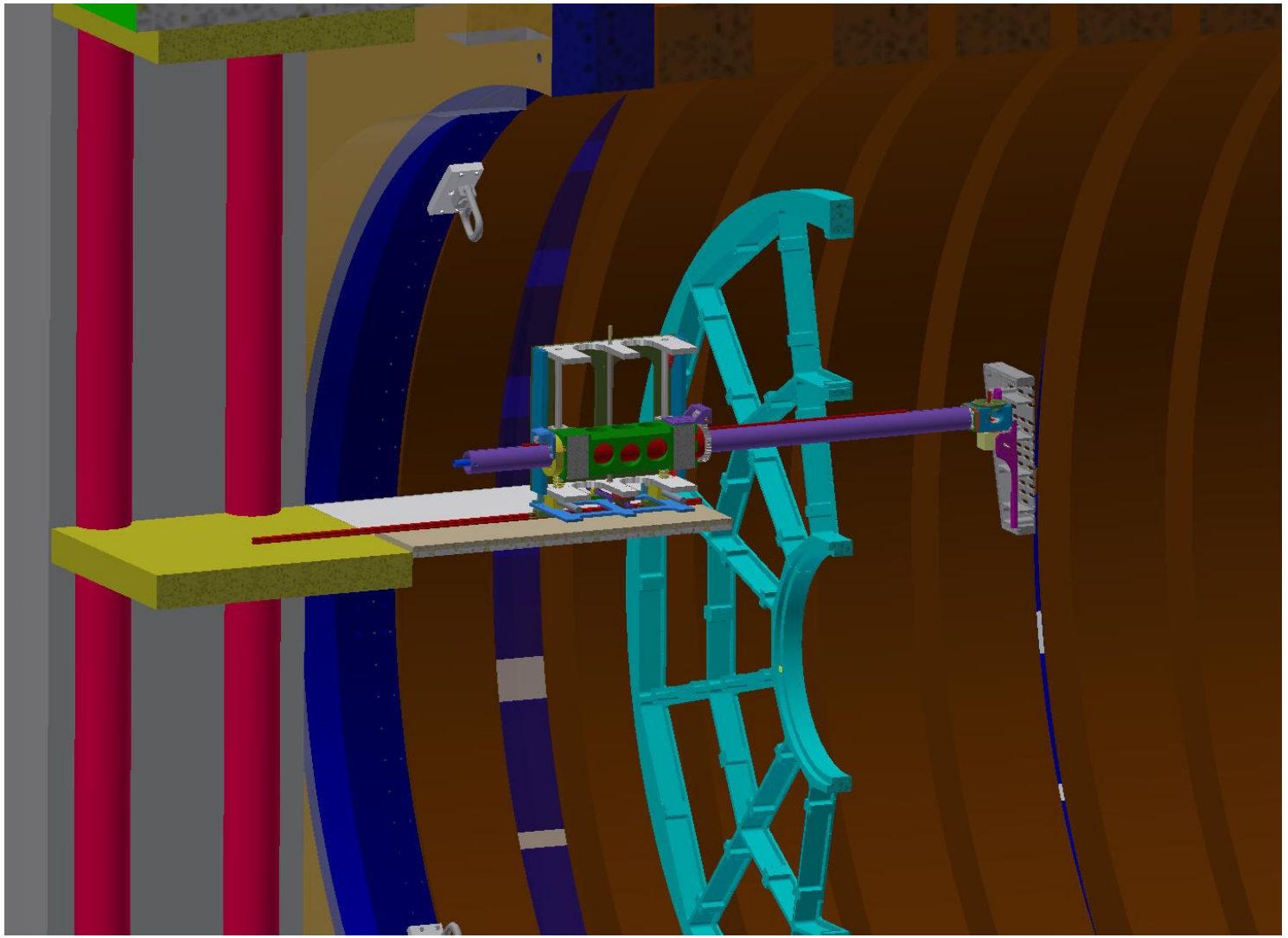




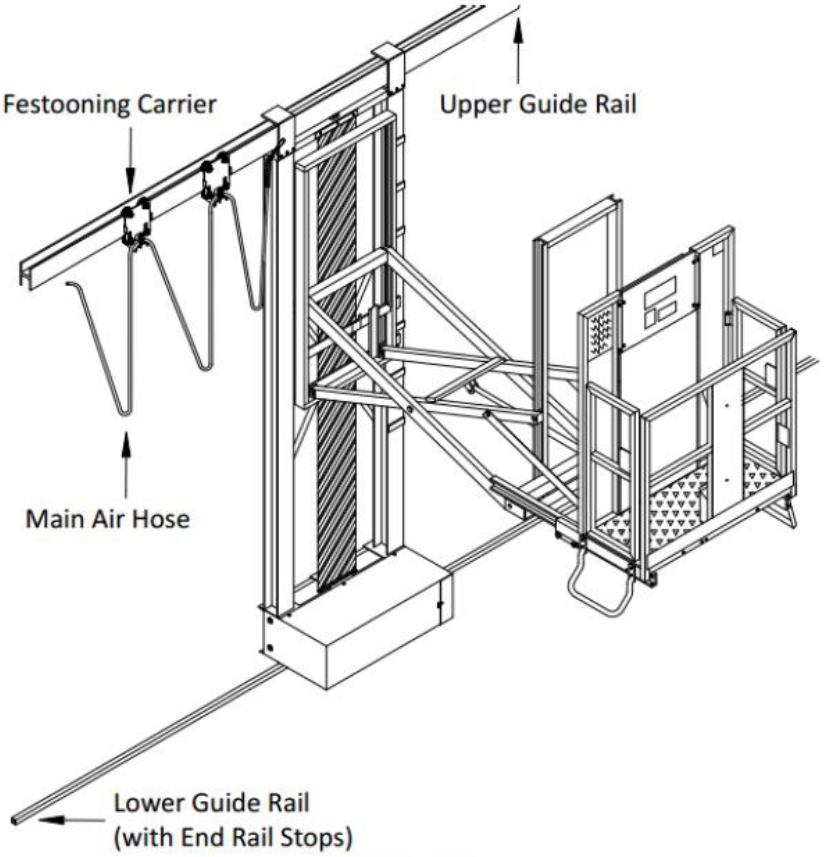
Installing 12o'clock outer sector

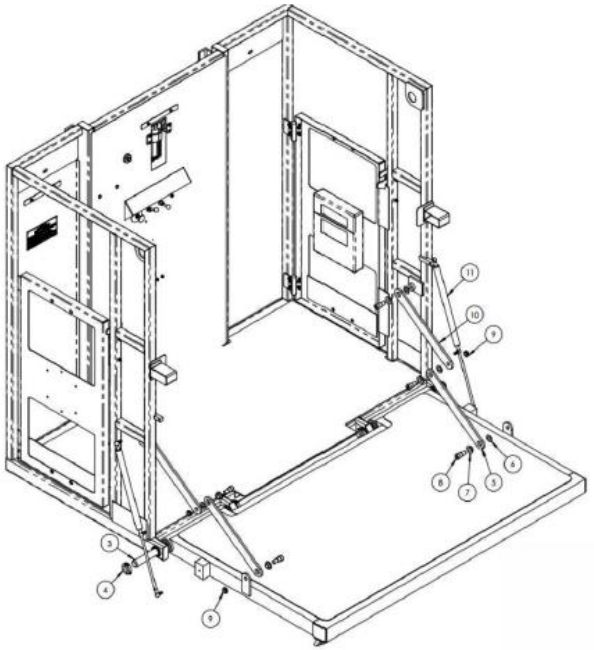


Sector Installation



Lift Platform Options – Light Duty





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Lift Platform Options – Light Duty

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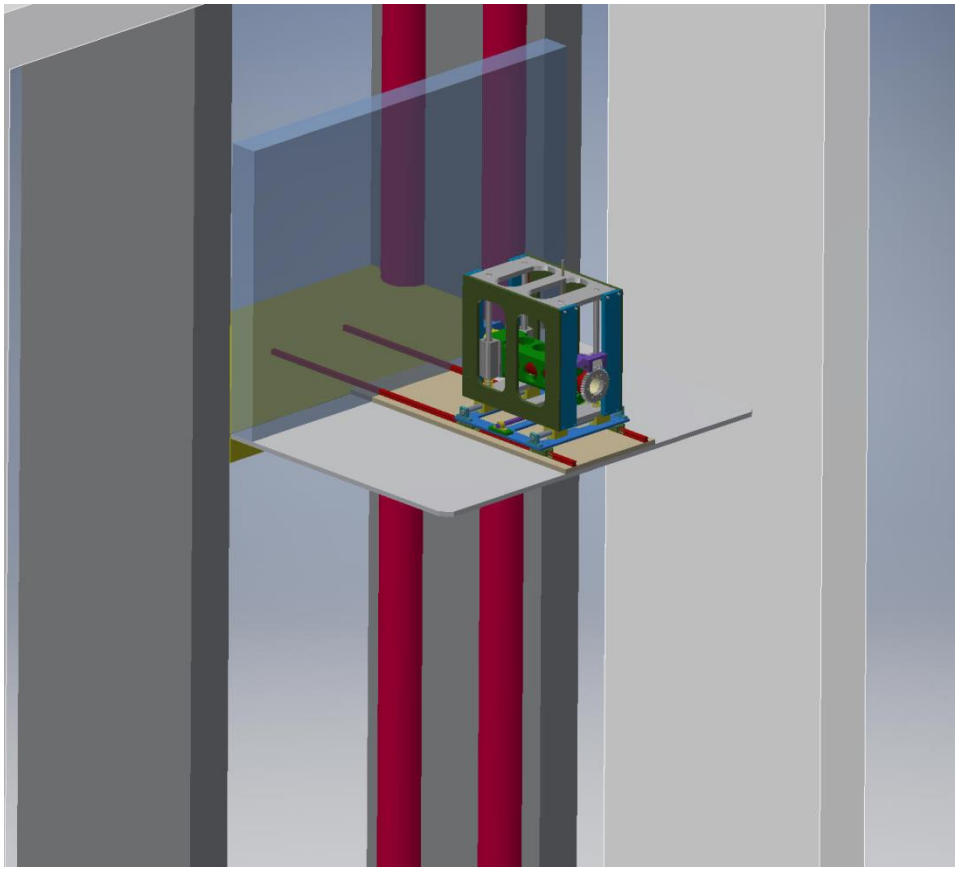
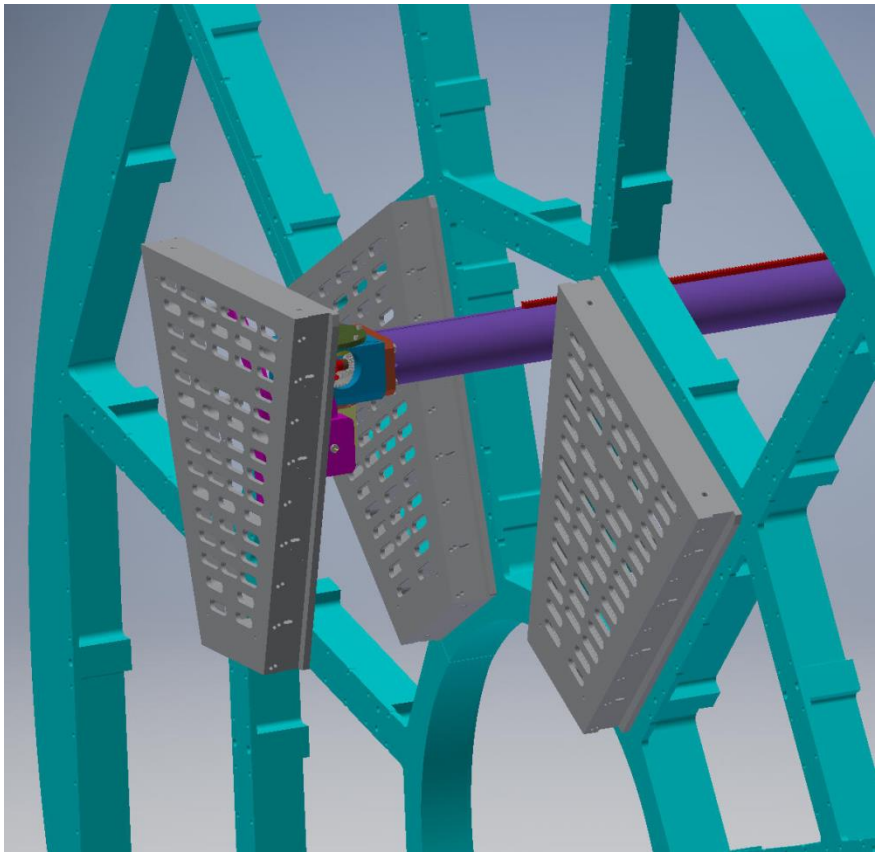
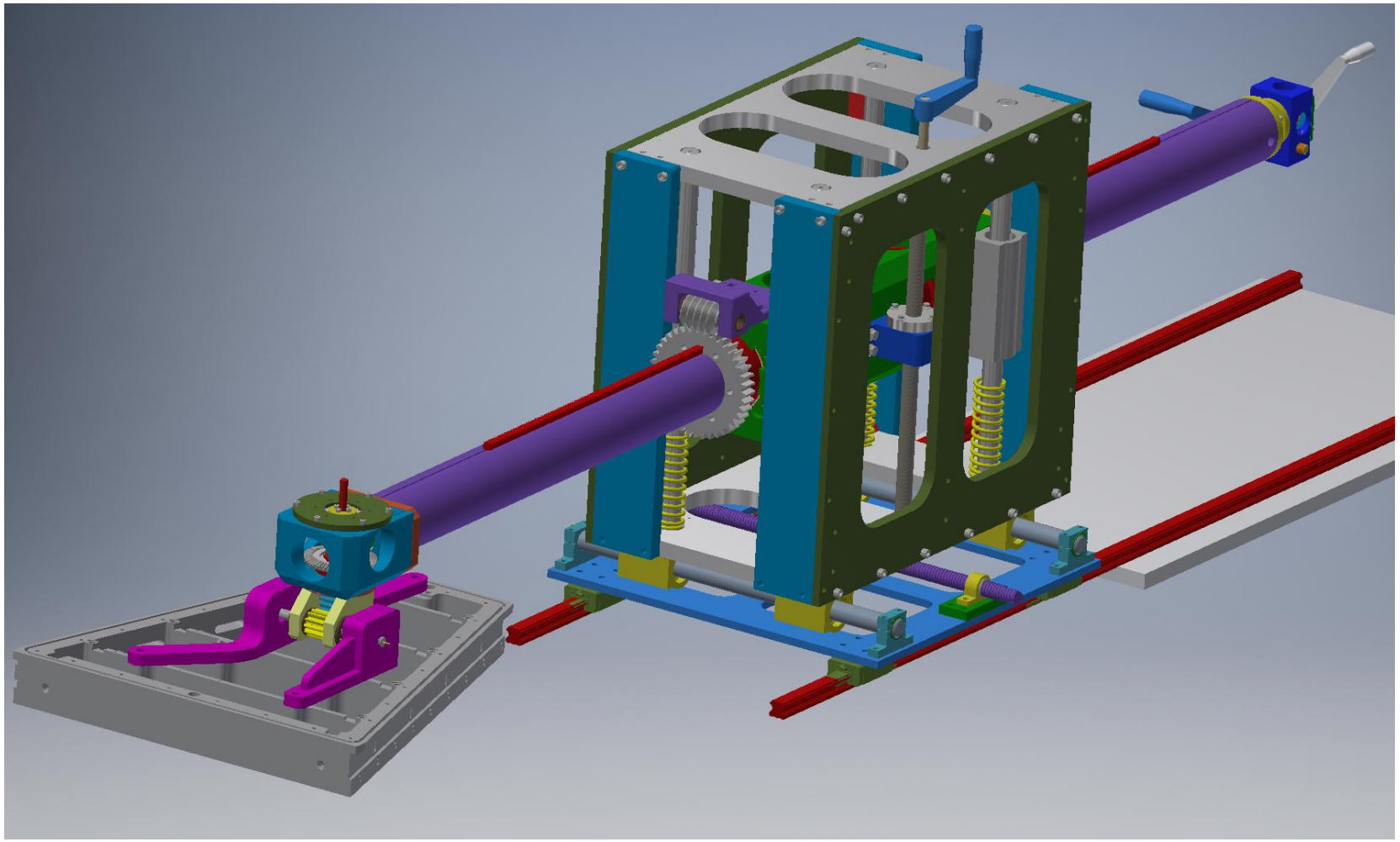
Sector Installation

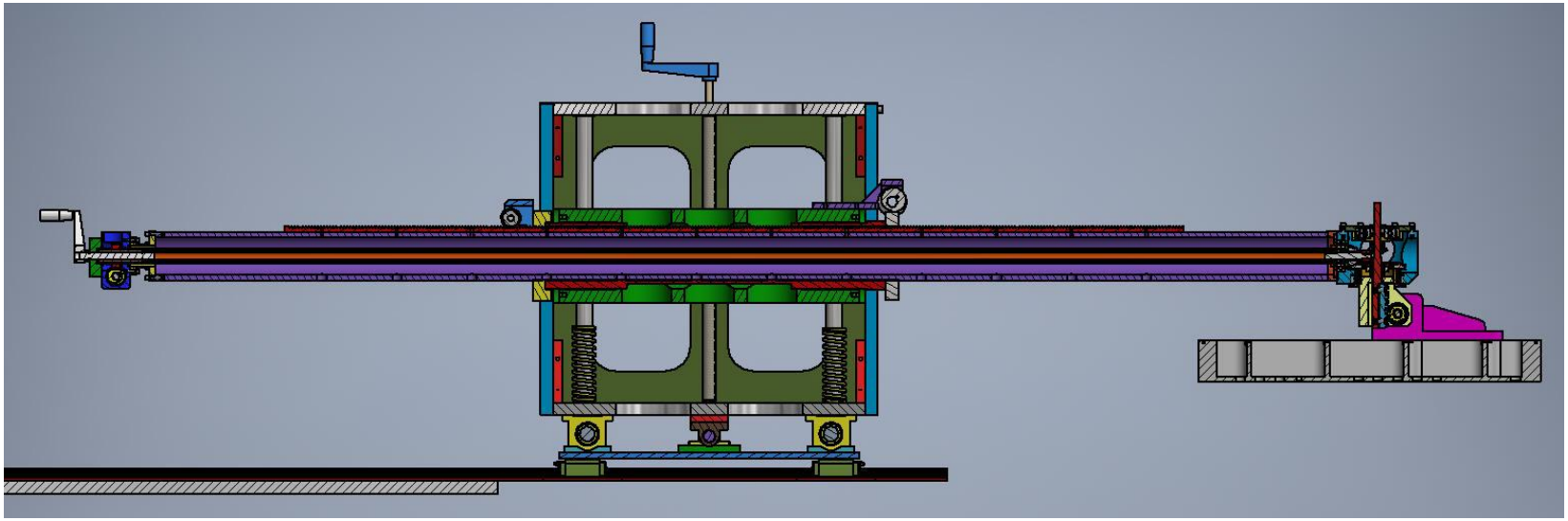


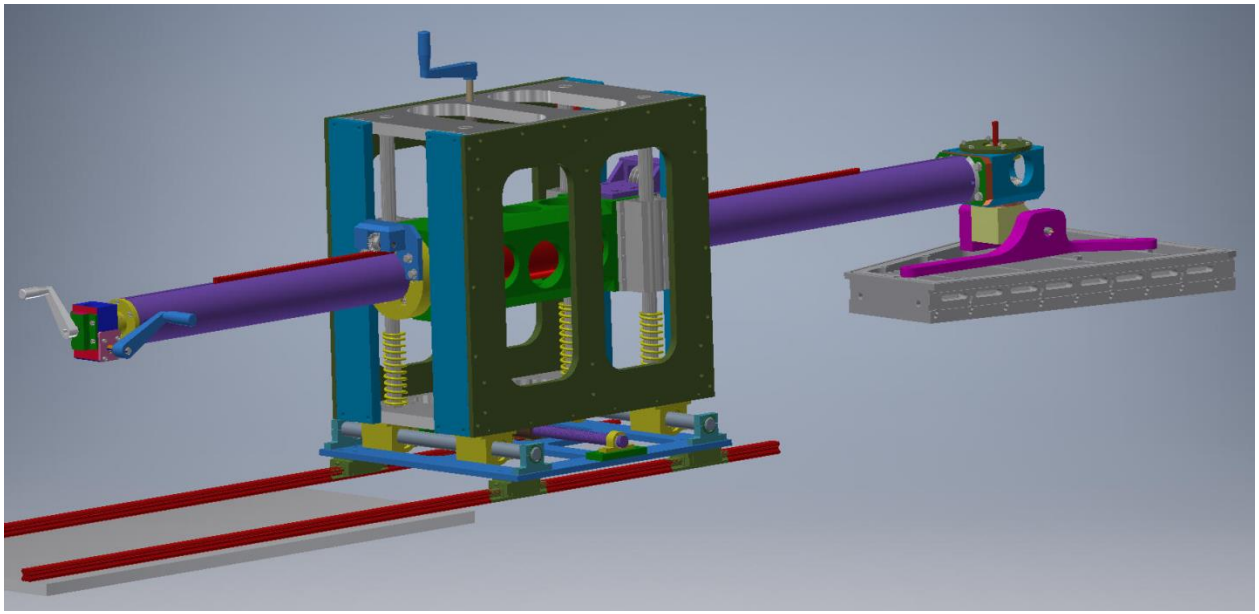


Sector installation tool

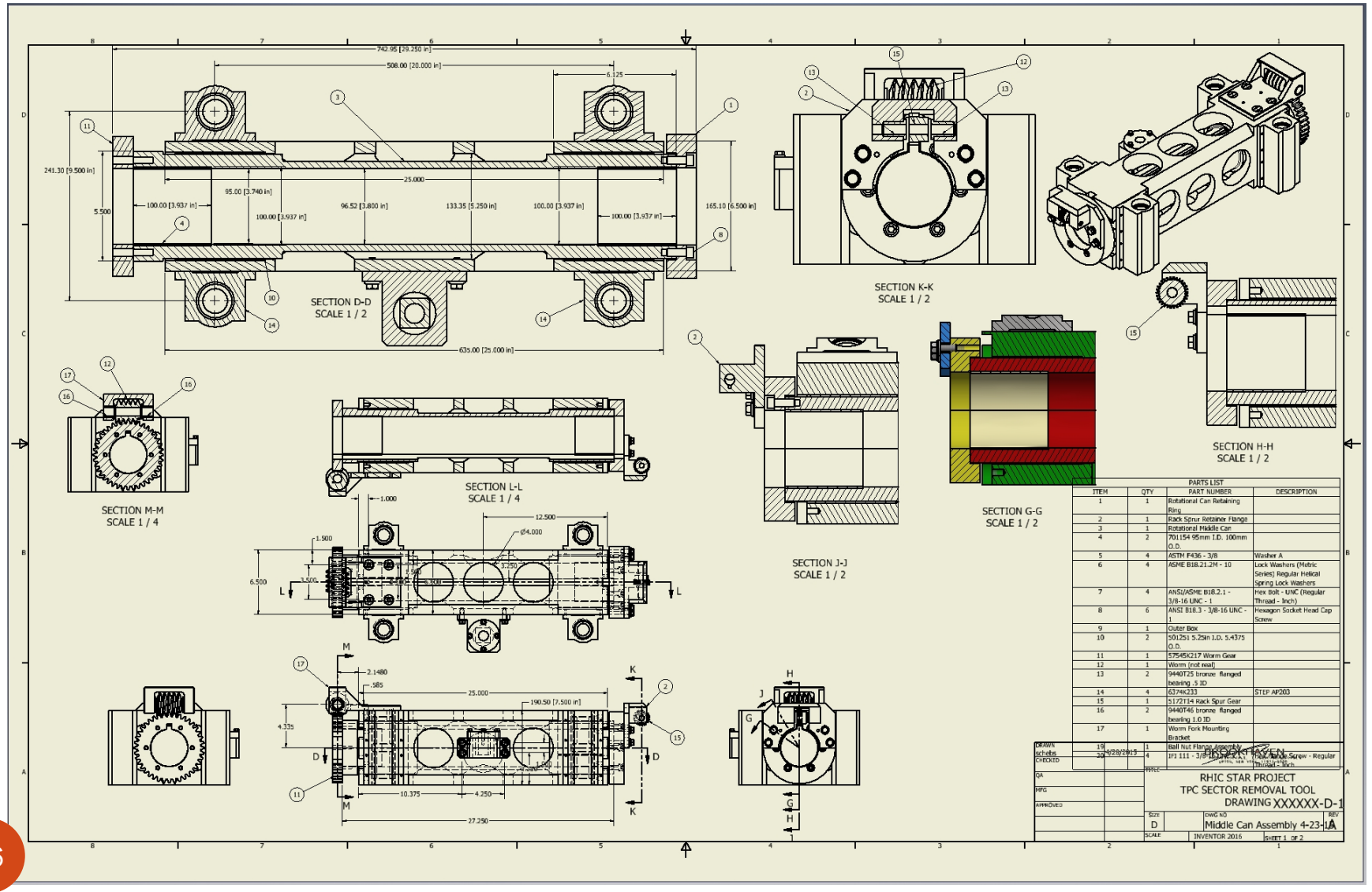


Sector installation tool

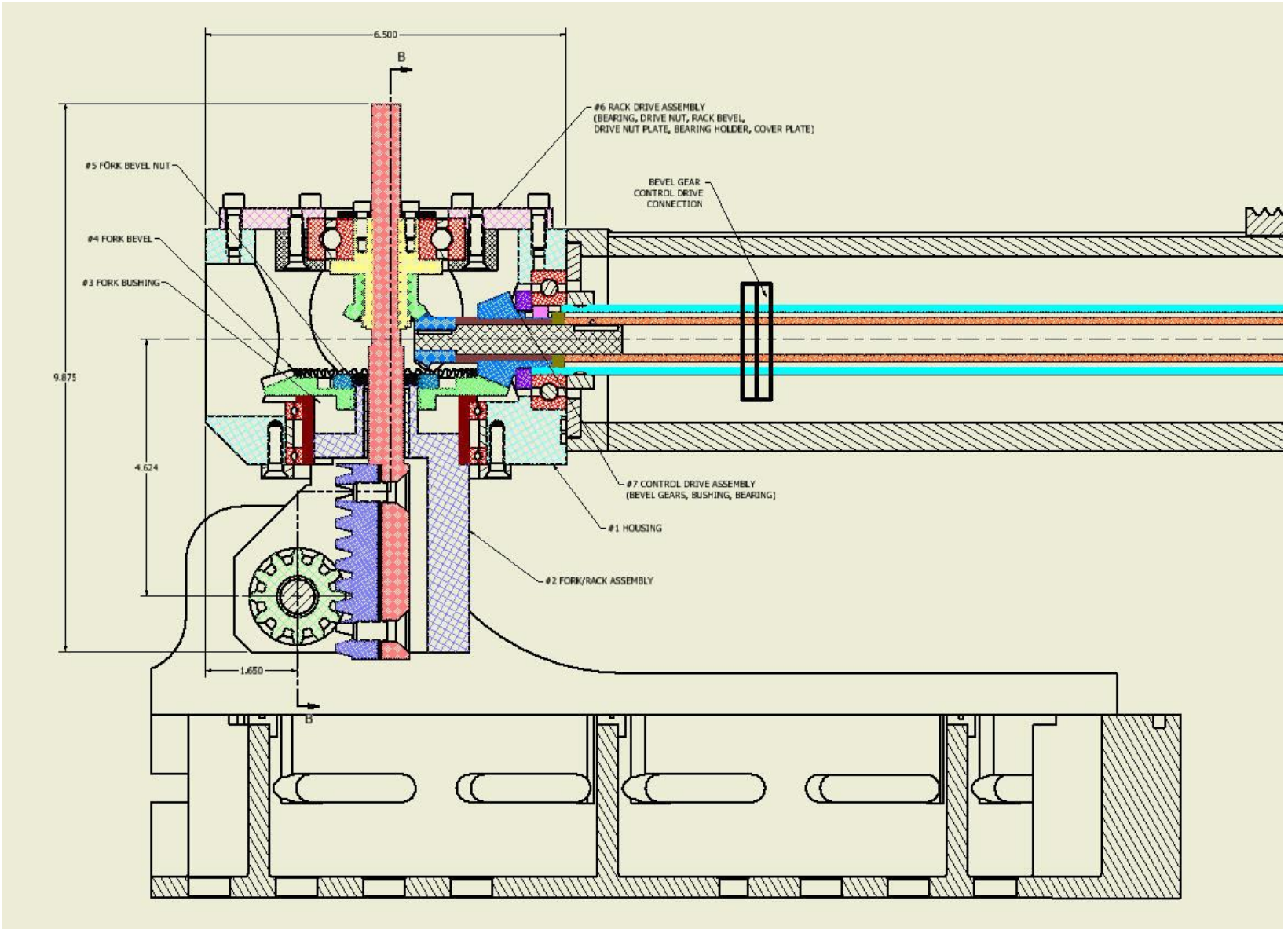




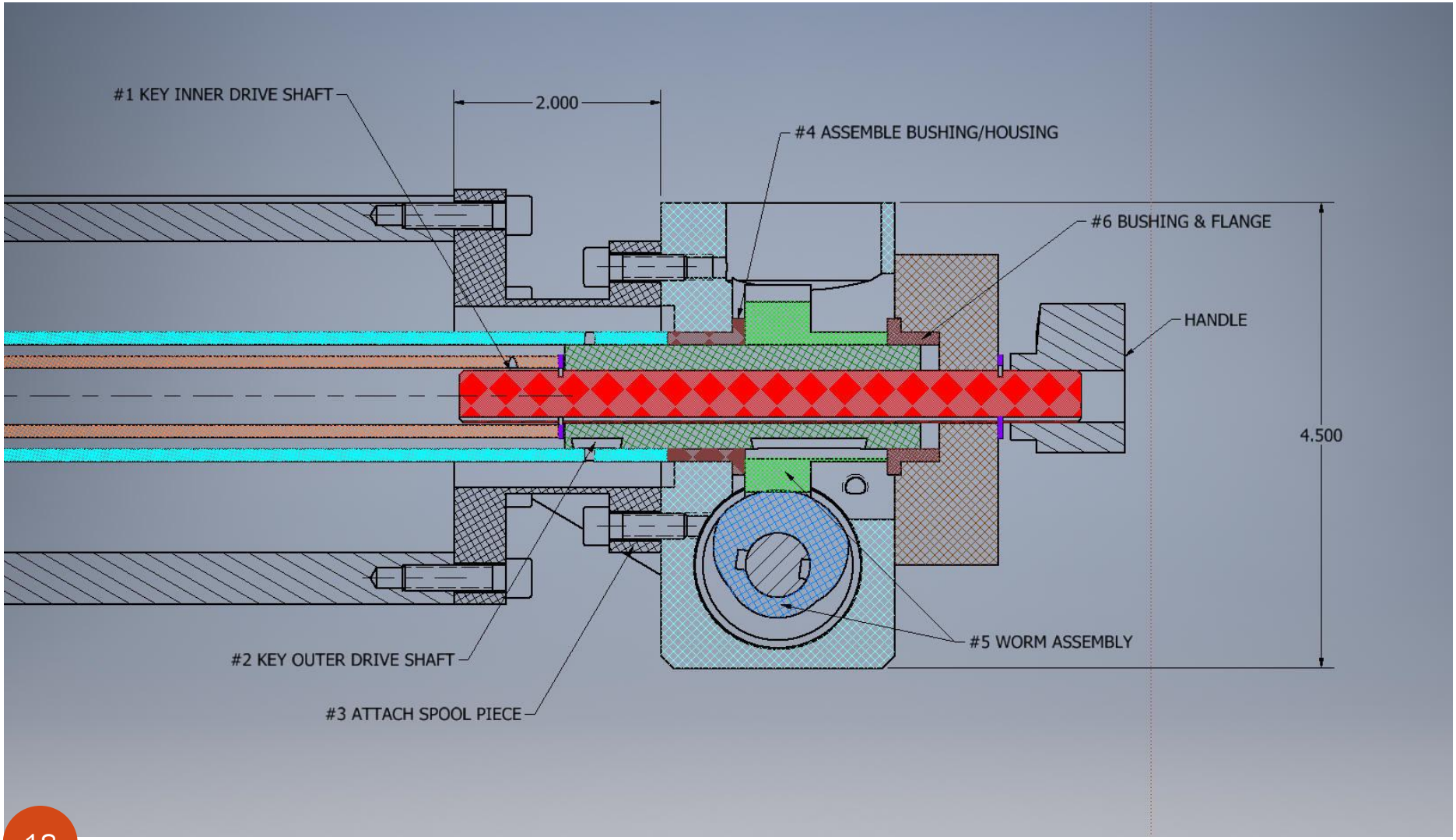
Outer and Middle Can assembly



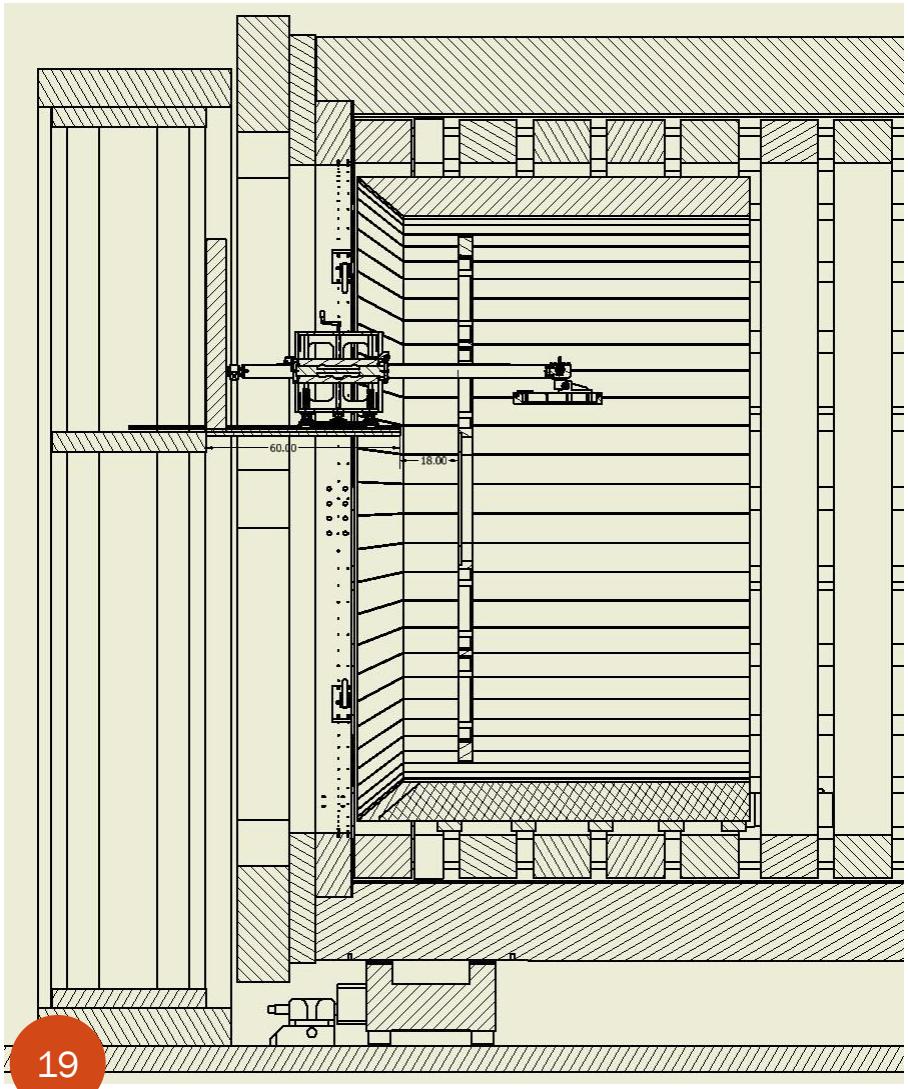
Gear Box

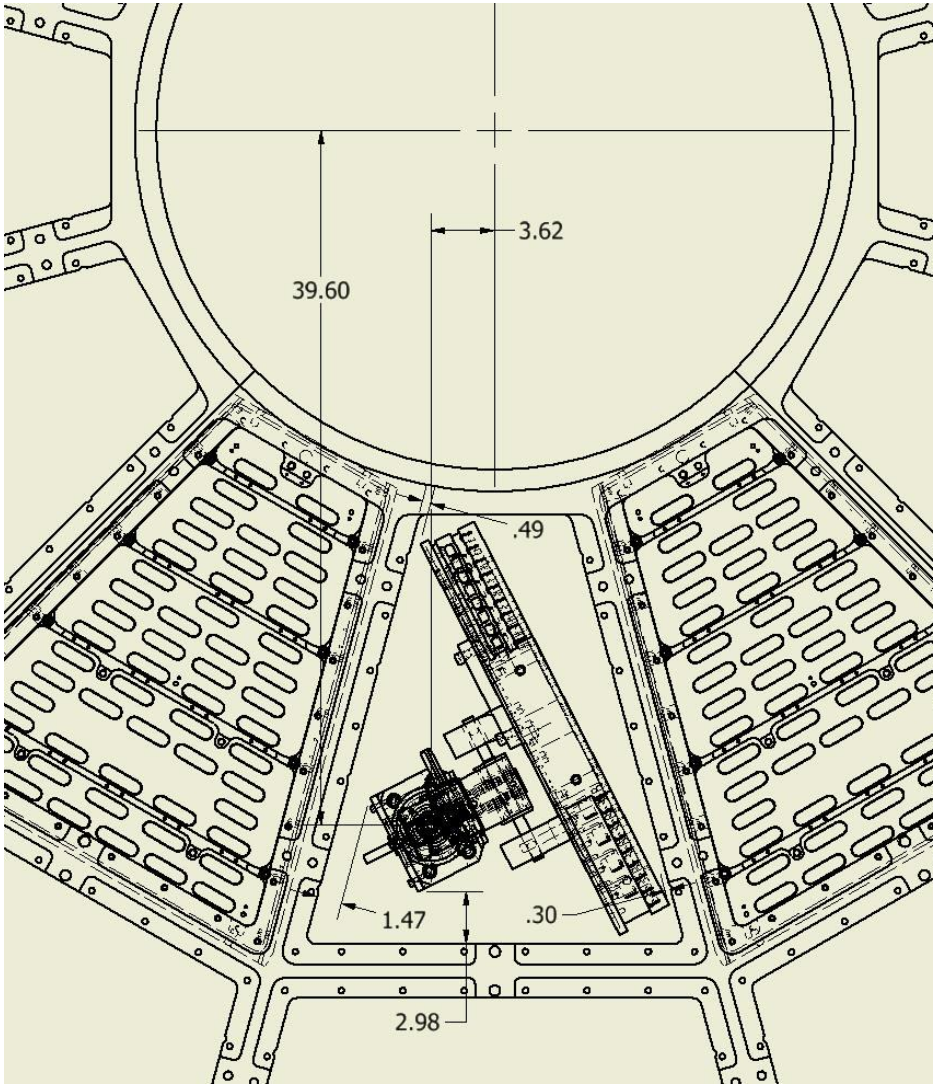

6.500
B
#6 RACK DRIVE ASSEMBLY
(BEARING, DRIVE NUT, RACK BEVEL,
DRIVE NUT PLATE, BEARING HOLDER, COVER PLATE)
#5 FORK BEVEL NUT
BEVEL GEAR
CONTROL DRIVE
CONNECTION
#4 FORK BEVEL
#3 FORK BUSHING
9.875
4.624
#7 CONTROL DRIVE ASSEMBLY
(BEVEL GEARS, BUSHING, BEARING)
#1 HOUSING
#2 FORK/RACK ASSEMBLY
1.650
B

Control Box


#1 KEY INNER DRIVE SHAFT
2.000
#4 ASSEMBLE BUSHING/HOUSING
#6 BUSHING & FLANGE
HANDLE
4.500
#5 WORM ASSEMBLY
#2 KEY OUTER DRIVE SHAFT
#3 ATTACH SPOOL PIECE

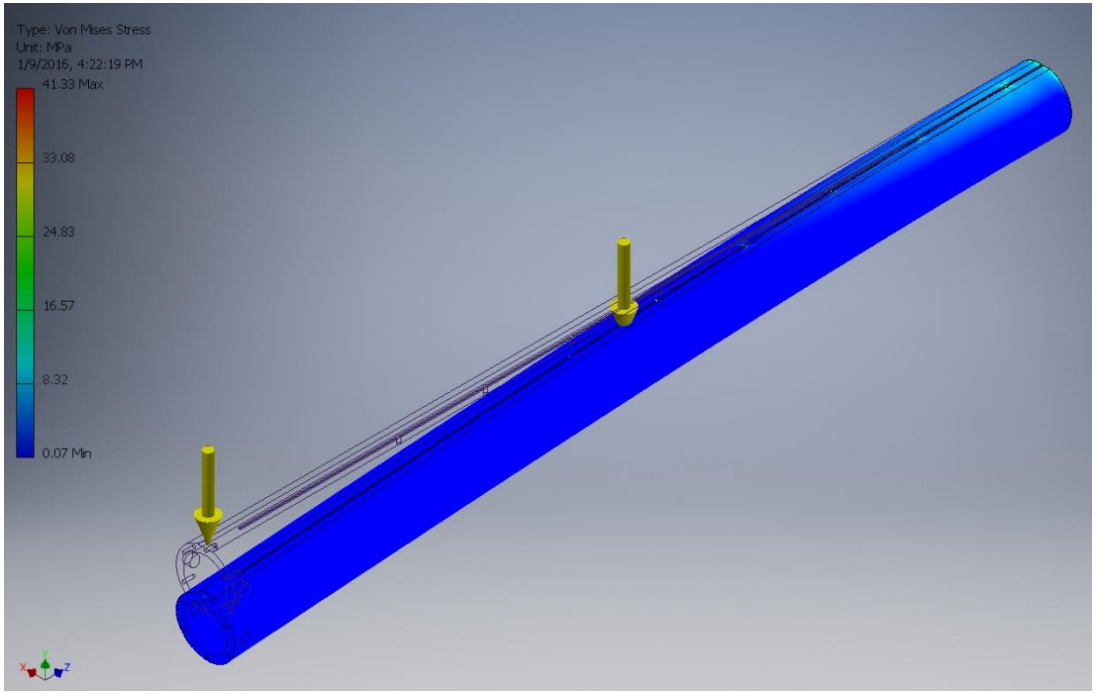
Sector Installation





Sector Mounting Shaft Analysis

- 4” dia shaft with 0.5” wall thickness
- Stresses in the shaft do not exceed 41.33 MPa.
- Maximum deflection in the shaft is around 0.97mm



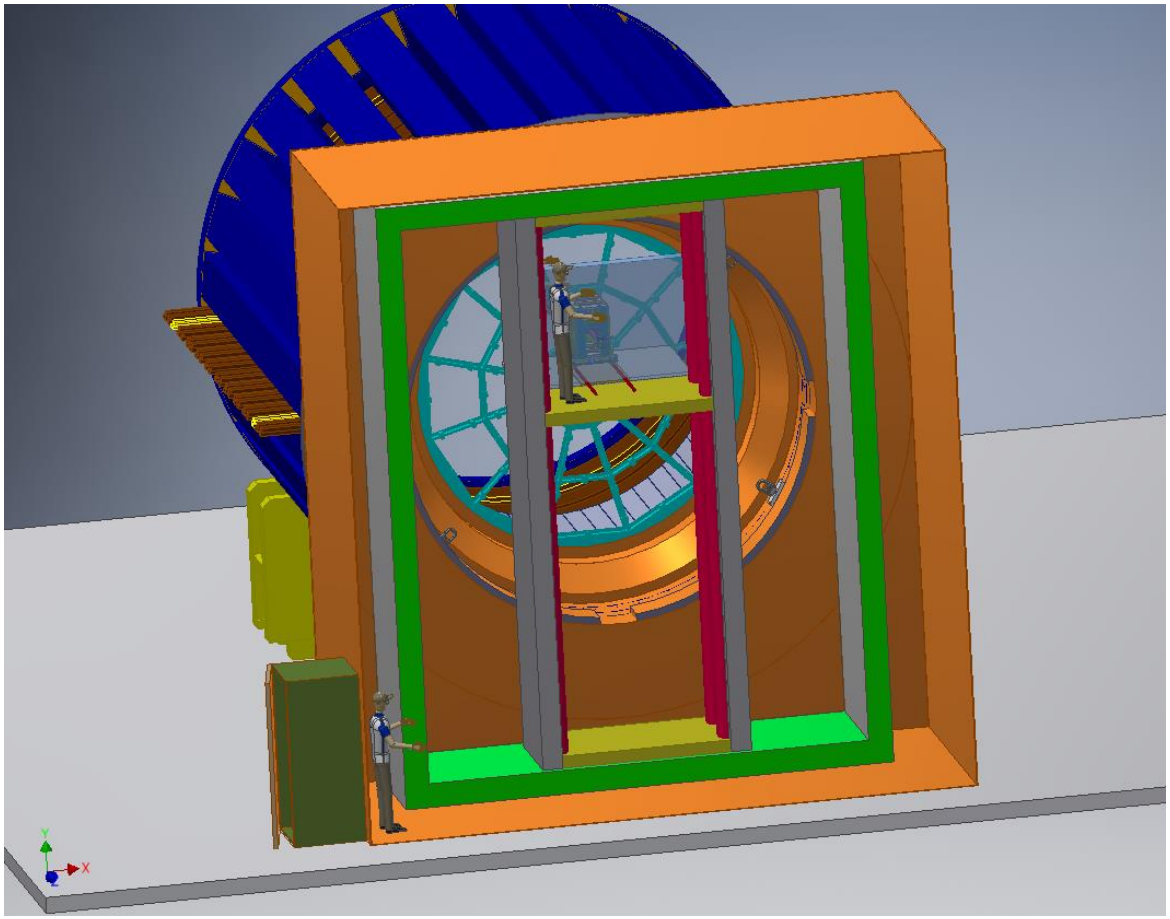
Investment Summary

Item	Amount
Design Engineering & Professional Services	$35,000
2 Axis Lift Platform	$124,897
Support Structural / Installation Kit	$21,659
On-site Support (Tech during installation, Training)	$9,165
Outbound Freight to BNL	$3,900
TOTAL	**$ 194,621**

Project Schedule

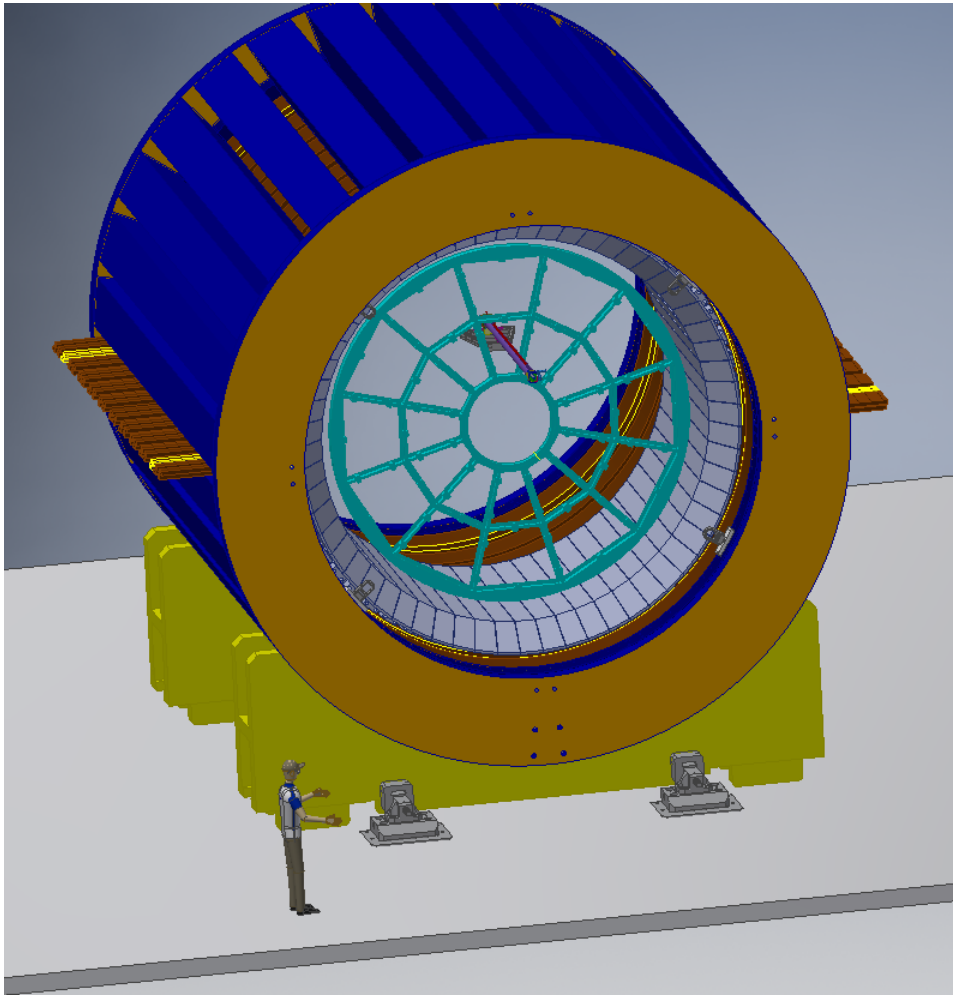
Item	Date
PO in place with the company	April 2016
Design of the platform complete	June 2016
Design review for the tool	January 2016
Design of the installation tool complete	March 2016
Manufacturing of the platform and the tool	Oct 2016 March 2017
Testing of tool and platform using mockup	March 2017 to Dec 2017

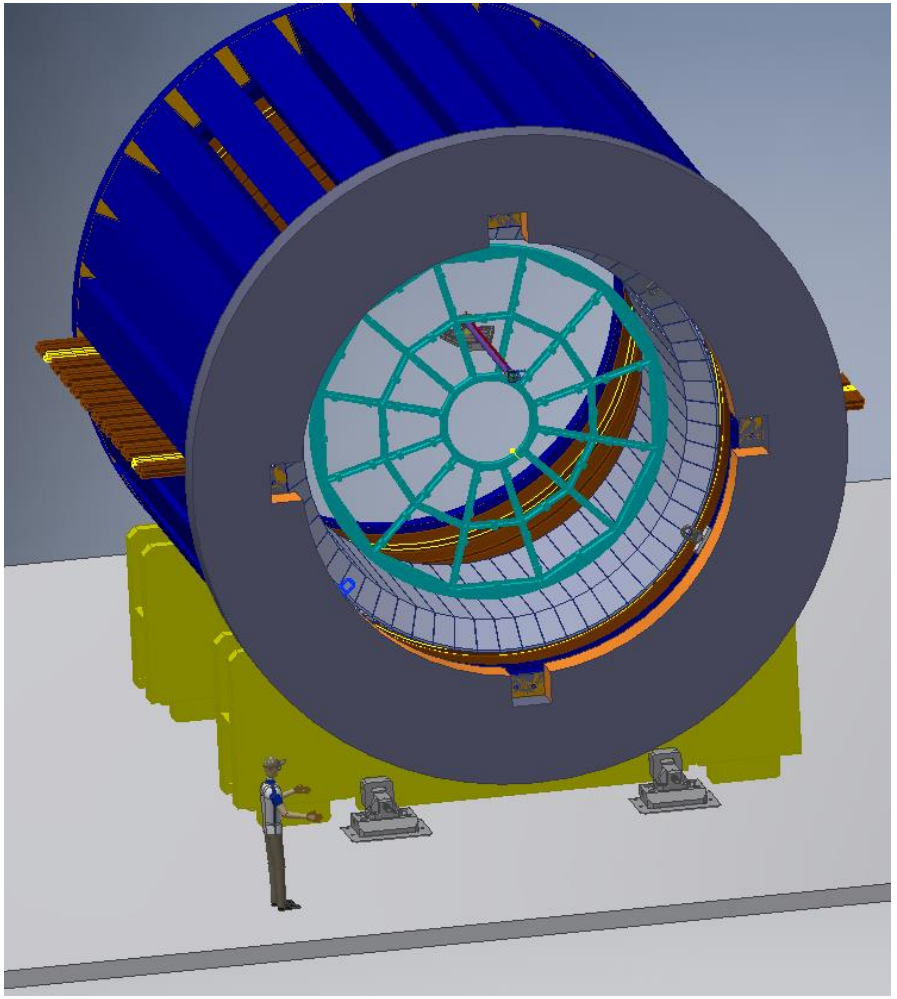
Clean Room Construction



- Cleanliness requirements will be met in 2 steps:
  - By building cleanroom around the face of the magnet that will start from TPC face and will keep all the dirty components (cable trays and other dirty surfaces) outside.
  - Cover for the opening that will be put in place right after the old sector is taken out and will be removed when new sector is ready for insertion in the opening.

STAR Magnet with and without cable trays





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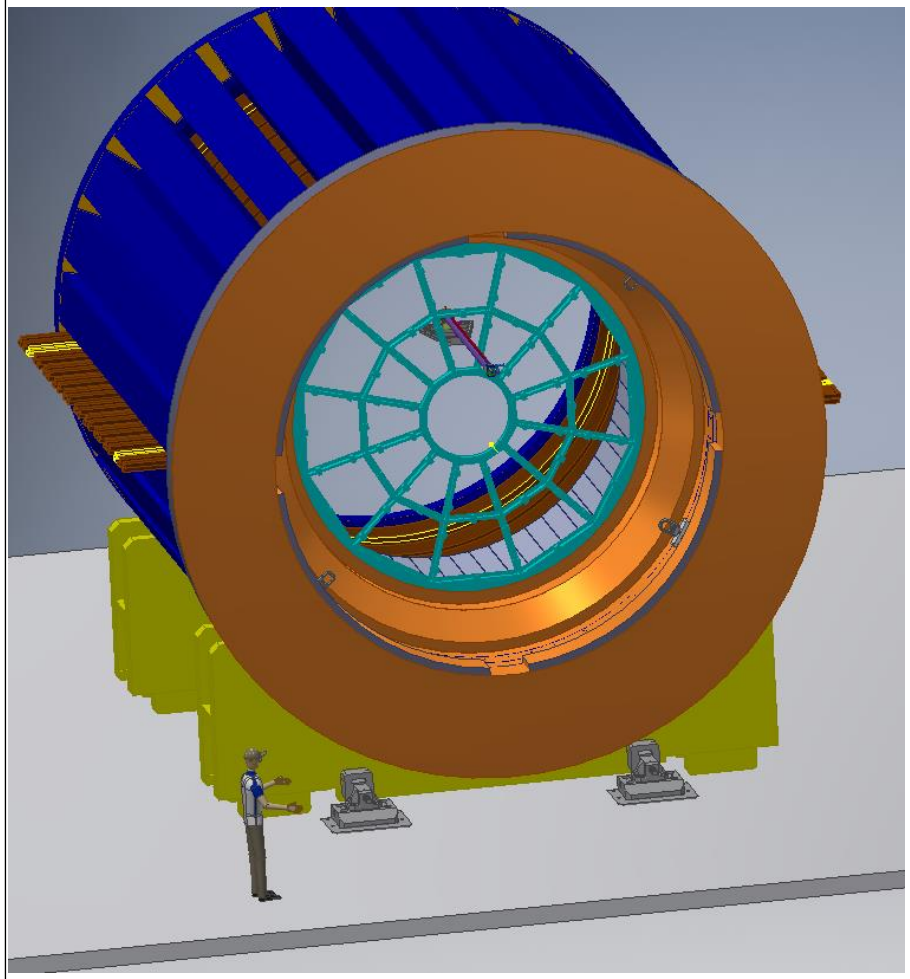
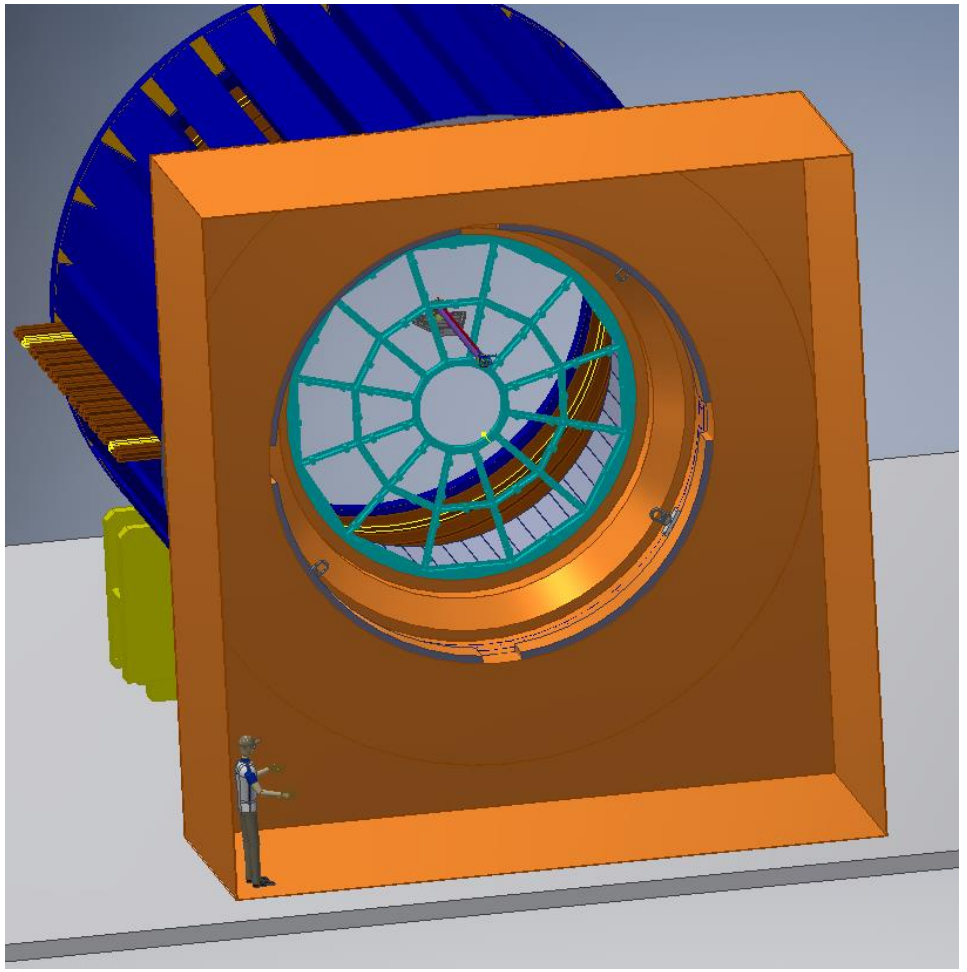
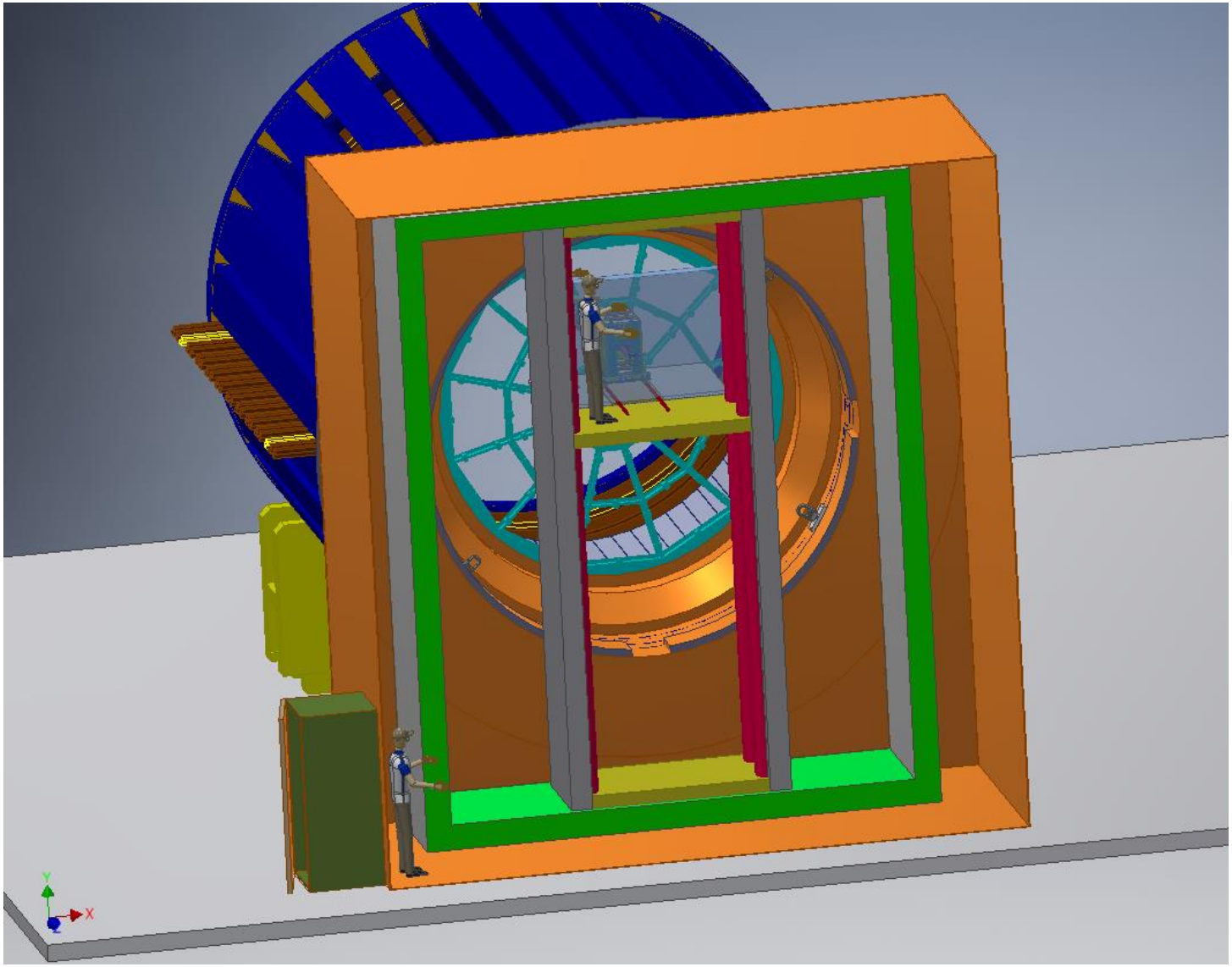




Clean Room Construction



Design Review Summary

- Overall Tool Design looks great
- Minor modifications were suggested by reviewers
- Tool design with all suggested improvements is expected to complete in March 2016 as shown in the schedule.

Cost

Item	Direct Cost	Cost with Overhead
Design and prototype of the tool	30k	46.8k
Platform Design	35k	54.6k
Platform Production	193k	301.08k
Manufacturing of the tool	50k	78k

Risks and Mitigation

- Risk 1) Installation tool not able to provide enough range of motion or degrees of freedom for sector installation with required precision.
- A complete analysis was done on the requirement of range of motion and insertion tool has enough range in both X and Y for this. The sector tool and platform will be available well in advance. The tool will be required to complete sector installation process on mockup multiple times making sure it works fine and can complete desired task.

- Risk 2) Sector hits the IFC or adjacent sector causing damage during installation.
- The clearance between the sectors is about 3.5mm during installation. A great deal of caution is required during the installation to avoid damaging adjacent sectors and IFC. Deflection in tool components and any vibrations during tool operation can make this problem worse. Mockup design explained in first step will include features mimicking IFC and adjacent sector walls to make sure tool chattering or vibrations are not going to become a problem during actual installation.

- Risk 3) Installation tool fails during the installation and causing either sector to fall in the TPC or get stuck in a non retrievable position.
- To mitigate this installation tool components will be designed with enough factor of safety. All components will be mechanical and will be hand-cranked to achieve desired motion in a controlled manner. Testing will be done multiple times in all challenging orientations to make sure the tool can achieve desired goals.